MEMORANDUN FOR RECORD 18 July 2005

SUBJECT: Chesapeake Bay Sediment Transport Model Review

The second meeting of the sediment transport model principal investigators and review team members was held 12 and 13 July at the USEPA Chesapeake Bay Program offices in Annapolis, MD. The study "Evaluation of Suspended Solids Transport and of Living Resource Interactions in the Chesapeake Bay System" was initiated last year and is to be completed by the summer of 2007. Various field investigations of conditions and processes were performed in the early phase of the study and are largely complete. The current focus is on model development, adjustment, and data assimilation. Study overviews were presented by Carl Cerco and details of the hydrodynamic, wave, and sediment transport modeling were presented by Sung-Chan Kim. Study elements were described clearly and there was ample time for discussion.

A number of investigations support the sediment modeling and were reported on. Some erosion experiment results have not yet been reported (Gust chamber) while two other erosion studies (sea carrousel and SEDFLUME) have produced initial results. Bank erosion studies of the Maryland portion of the bay (by MDE) will be completed this year. A simple approach to estimate bank sediment losses is planned for the Virginia portion of the bay. Investigations on light attenuation, plankton sinking, and flocculation are ongoing.

Hydrodynamic, wave, boundary layer, and water quality model components will be operated separately over the period 1993 to 2000. (The sediment model will be part of the water quality model.) Since the last review, CH3D model geometry has been edited and sensitivity tests using direct precipitation to the bay were performed. Salinity distributions are reasonable, but not perfect. The remainder of the water quality model is being implemented incrementally and tested, starting with the previous Chesapeake Bay model, and, when it becomes operational, will guide the hydrodynamic model. Several turbulence model parameters will be tested in an effort to improve vertical mixing.

The wave model was developed and tested since the last review. It's an analytic depth- and fetch-limited wave formulation based on Young and Verhagen (1996). Results have been compared to those from the more elaborate SWAN and GLERL numerical models and to field data. While wave height results appear to be reasonable, wave period results are often much lower than field observations. In both cases, the new analytic results appeared to be no worse than the other models. Wave and current shear stresses will be merged in a boundary layer model, under development at VIMS, before being passed to the sediment model. The sediment model is under development, but will resemble the SEDZLJ sediment model.

Sediment Transport Review Team comments. Reviewers Allen Teeter (AT), CHT,llc, Earl Hayter (EH), USEPA, and Chris Sherwood (CS), USGS and special reviewer Billy Johnson (BJ), CHT,llc, offer the following comments and/or recommendations on the present state and direction of the model development after hearing the PI presentations.

AT:
1. Plot up residual circulation from the new model and compare to empirical expressions developed during previous model studies. Circulation and vertical mixing are coupled and circulation should be nailed down before spending much time on vertical mixing. The new boundary location might be affecting tidal residual circulation in the seaward end of the grid.
2. Phasing between diurnal and semi-diurnal water level and current components should be examined and is a good check on system geometry. The correlation between water level and current velocity is often important to sediment transport.
3. Model-predicted wave periods will strongly affect computed shear stresses and need to be resolved. A high-quality portion of the available wave (and wind) data should be examined in detail. Dimensionless wave frequency and depth from field data should be plotted and compared to Young and Verhagen's expression. If data are well-banded but offset from the model, a model coefficient adjustment might be indicated. If the data are scattered to one side of the model, another model step, i.e. switching to an alternate formulation, might be indicated. (My experience in the ultra-shallow Laguna Madre indicted that a dimensionless frequency U*/g Tp where U* = Cd^0.5 Ua was better correlated to dimensionless depth.)
4. Sediment model process equations vary between models, and the modelers should be prepared to swap out these equations if necessary to obtain the best comparison to field data. Since time and the budget limited, expedite implementation of the sediment model.

EH:
1. When the bank erosion routine is added to the sediment transport model, the eroded mass per unit time will have to be fractionated into each modeled sediment class size. Also, will this non-point source be added directly to the bottom in the cell adjacent to the eroding bank, or will the fine-grained fraction be assumed to enter the water column?
2. I think it is very important to fully couple the water quality and sediment transport models by accounting for fraction of organic matter (along with the inorganic sediment) in each bed layer. Thus, if resuspension is predicted to occur, the mass of organic matter in the eroded layer will have to be added to the water column along with the eroded inorganic sediment. When deposition occurs, the mass of both the organic and inorganic solids will have to be added to the surficial bed layer. The settling velocities of both components of the TSS will also have to be predicted.
3. Even though it will only affect a relatively small portion of the modeling domain near the ocean boundary, I think some estimate of the flux of sand into the bay from the ocean should be added to the ocean boundary condition.
4. I remain concerned about the disagreement between model predictions and measurements of salinity at the station closest to the ocean boundary.
5. I think that both rainfall and evaporation should be added to the CH3D hydro model.
6. I encourage Sung-Chan to continue his efforts to improve upon the model's ability to represent vertical stratification, and specifically, to follow up on his comment to investigate using the friction velocity calculated by Courtney's boundary layer model.
7. As mentioned during the meeting, I think the strategy of running the sediment transport model for several months to a year using some initially assumed bed

composition might be a good way to spin-up the largely unknown initial bed composition.

CS:
1. A consistent strategy should be developed by the modelers to identify, and put most effort into, those hydrodynamic/sediment transport parameters (state variables or coefficients) that are most important to the success of the water quality model.
2. Use an appropriate statistic, e.g. Wilmott (1981) to document improvements in model validation during adjustment.
3. Re-investigate the spatial variability in the wind field and possible effects on waves, shear stress, and mixing, particularly in shallow regions. Also, look at surface mixed layer model and make sure effect of wind stress on vertical mixing is working well.
4. Three grain-sizes might not be enough for the light model.
5. Bed properties must be right and consistent with model hydrodynamics. It might require iterative calculations to best assign the initial distribution of bed properties.
6. To determine how to best improve vertical mixing, evaluate salinity and heat budgets and looks at relative importance of advective and diffusive fluxes through the pycnocline and through estuary cross-sections.

BJ:
1. With limited funding and several differences between the new grid and the old 12,000 cell grid (e.g. bathymetry), discontinue the comparison of results on the two grids. Focus on the new one.
2. Generate residual velocity plots over the grid and compare with the Blumberg data and any other data available.
3. Generate vertical profiles of eddy viscosity and diffusivity over the grid. How do they compare with the general shape that is applicable for stratified estuaries?
4. Before putting forth a lot of effort to incorporate results from the VIMS boundary layer model into the turbulence model, do some sensitivity runs.
5. Since temperature computations are primarily driven by surface heat exchange and vertical mixing, focus on the temperature profile when “tweaking” the turbulence model.

- Allen Teeter, Ph.D.